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INSTRUMENT SECTION.

W. P. Jesse, Section Chief,
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AIR PROPORTIONAL ALPHA COUNTERS.

J. A. Simpson, Jr.

October 8, 1945.

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AIR PROPORTIONAL ALPHA COUNTERS.

(On work covering October-December 1944.)

J. A. Simpson, Jr.

I. INTRODUCTION.

The purpose of this report is to introduce the use of proportional counters, whose ionizing gas is air at atmospheric pressure, as the basis for the development of a series of radiation detection and measuring instruments. It also covers interesting properties of these counters (such as air as an ionizing counter gas) and various counter designs. A subsequent series of reports will describe specific instruments which have been developed utilizing these air proportional counters, such as: an alpha counter for measuring hand and clothing contamination, portable probes and meters for making quantitative measurements and survey probes and micro counters for health protection. Boron, paraffin or a "heavy metal" coated surface in air counters is also useful in survey work for neutron detection.

The use of air in a proportional counter has been reported early in the literature.[1] However, these counters were generally of a so-called "end-window" design which distinctly limited both the geometry and the size of center-wires used. They were characterized by a very high operating potential, low geometry and mechanical instability.

II. AIR AS A GAS MIXTURE FOR DETECTING IONIZING EVENTS.

Admittedly, air is a very poor choice for a counter gas mixture, but the important advantage gained in using counters at atmospheric pressure with no windows or windows of high transmission for detecting alpha particles along with the attendant simplicity of such a counter design makes this poor choice worthy of consideration.

The oxygen and carbon dioxide content of the air introduces the problem of negative ion formation. The electron attachment for oxygen is 1.73 ev. and results in

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1. G. Brubaker and E. Pollard, Rev. Sci. Int. 8, 255 (1937).

[redacted]

a serious loss of electrons formed in the primary ionization of air by, say, an alpha particle. This is especially true in the outer or low intensity field region of a proportional counter. Such an effect is observed as an apparent decrease in counter efficiency and, in the semi-proportional region, as an observable number of spurious counts. This latter effect results from the detachment of the electron from the oxygen molecule when it approaches the center-wire a considerable time after the ionizing event has been completed. The above deviations from linearity are important for particle energy measurements, but, in most cases, are negligible for determining the number of ionizing events.

The presence of nitrogen in the counter results in a relatively high operating potential. As will be seen later, this requires that very small center-wire diameters be used in order to obtain adequate gas amplification at moderate potentials. Such center-wires or anodes, therefore, require mechanical support at both ends of the wires, and this fact encourages the use of windows which run parallel to the direction of the center-wires.

Recombination of the ions formed in the air is negligible in these counters except for precise particle energy measurements.

Maximum daily fluctuations of atmospheric pressure are about 1 cm. Hg. which introduce a shift in the threshold potential of approximately 15-20 volts with counters using 0.001" diameter center-wires. This shift is linear over a range of at least 20 cm. Hg. pressure (Figure I) around atmospheric pressure. For alpha and proton survey and detection instruments this does not introduce serious errors.

At room temperature, there is a 1% change in counter counting-rate at the operating potential with a 1° F. change in temperature. The data in Figure 2 are representative of air proportional counters.

The water vapor content of the air changes with time and, therefore, it is important to understand how air counters may behave at high relative humidities. All counters, irrespective of how they are prepared, show no relative humidity effect up to 60-70%. Near this value, those counters which have dirty or scratched insulators (polystyrene) will show a peculiar spurious counting effect which behaves like a counter with a high background, except that the counts are not random. Counters with moderately clean insulators may show the effect above 85% relative humidity. Counters which have insulators whose surfaces have been cleaned and polished according to CP-2852 and have all surfaces sufficiently above room temperature show no spurious counting effect, even near 100% relative humidity.

The manner in which spurious counts are produced by water vapor has been examined. Many types of insulators were treated with a wide variety of surface coatings--including silicones, G.E. Varnish, and various cleaning methods. The surface resistance of standard prepared plastic samples was measured on a recording vibrating reed electrometer under various humidity conditions. The surface resistance was shown to change orders of magnitude in value within a few seconds. Their behavior was quite erratic. Such rapid surface resistance changes produce pulses several millivolts in magnitude within a counter. Baked silicones and G.E. Varnish on polystyrene could produce stable surfaces, but this preparation is rather critical. It was found that the best surfaces were prepared from carefully buffed and polished polystyrene. The surface was washed in tincture of green soap and distilled water; no oil remained on the surface.

Tests were made to determine the sensitivity of open air counters to steam. A stream of steam was blown by a fan into various counters; the backgrounds rose by only a factor of 3. (Details on the effect of water vapor on specific counter designs will be discussed later.)

At atmospheric pressure, the background beta pulse size is somewhat higher than at lower pressures, due to greater ionization per centimeter path length, but there is still a large factor in the separation of the alpha pulse distribution from the beta pulse distribution enabling one to count protons or alpha particles in an intense beam of beta particles or gamma rays.

III. DISCHARGE MECHANISM IN AIR.

In order to utilize air proportional counters, it is necessary to understand the principal differences between the electrical discharge mechanism in a polyatomic gas and the discharge mechanism in a mixture of gases--such as air. The properties of the discharge mechanism for various types of gases used in the proportional region have been discuss-

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ed.[2,3] If, for example, an alpha particle passes through an air counter operating in the proportional region, many ion pairs are formed. A few of the electrons thus formed in the counter volume and accelerated toward the anode become attached to oxygen molecules to form negative ions. The other electrons reach the region immediately surrounding the center-wire, and in this region of high field intensity acquire enough energy between collisions with molecules and atoms to produce ionization upon collision. The threshold voltage of the proportional region is determined by the potential applied between cathode and anode which is required to give an electron enough energy to produce ionization in its last mean-free path before being collected at the anode. An increase in the potential difference produces increasing ionization and multiplication at the center-wire. Many of the molecules in the discharge become excited and, in returning to their normal state, produce photons of considerable energy. The production of photons demonstrates one of the principal differences between this discharge process and one occurring in a polyatomic gas. A polyatomic molecule, instead of radiating a photon, may return to its normal state by dissipating its energy in rotation or vibration levels. In addition, any photons that are produced in the polyatomic gas must be of short range, because of the wide bands for photon absorption in such types of molecules. In contrast to this, an air discharge produces photons of considerable range since the absorption is rather small. Under such conditions, photo-electrons may be produced at the cathode surfaces which upon arriving near the anode produce additional multiplication in the gas. Obviously, under these conditions, the discharge will not be proportional to the original ionizing event. Therefore, in air counters the proportional region is limited to the region lying above the proportional threshold and below the point where photons play a significant role. Experimentally, it has been verified that this multiplication or gas amplification in the counter for air extends up to approximately 10^3, whereas a higher order of magnitude of gas amplification can be reached with polyatomic gases.

Expressions derived in the literature for the amplification factor A (E) i.e., the ion multiplication as a function of field intensity, are not correct for application to air counters principally because these equations were derived[3] on the assumption that no photons would be produced in the

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2. J.A.Simpson, Jr.-"Proportional Alpha Counters" CP-1527. pp. 3-5.
3. M.E.Rose and S.A.Korff, Phys. Rev. 59, 850 (1941).

[redacted]

counter discharge. The amplification factor is more critically dependent upon field intensity in the case of air counters than in the case of polyatomic gases and, therefore, it is expected that air counters will be more critically dependent on operating potential.

It can be deduced from experiments[3] on H_2 gas that the behavior of the amplification factor A(E) is dependent on the condition of the cathode material and construction only for high values of the amplification functions; i.e., in a region where photons are produced. Therefore, in the strictly proportional region of an air proportional counter, the material and structure of the cathode, aside from its effect on field distribution, is unimportant if it is free from insulating surfaces.

Positive ions which are produced in the air from the discharge are accelerated toward the cathode. Upon arriving at the cathode, they acquire electrons, but do not produce free electrons by field emission, principally because the charge is so small that no space charge can be formed.

The conventional signal resistor in series with the high voltage supply and the counter tube does not play the same important role in the proportional region that it does in the Geiger Mueller counter region. There is no so-called "quenching" by lowering of the center-wire potential, since the pulse height is usually the order of 10^{-2}-10^{-3} volt, and a counter is operated at least 10-60 volts above its proportional threshold. Therefore, the optimum choice of a resistor is determined solely by the discharge mechanism in the counter itself. This is so because the steepness of the voltage pulse front developed across a resistance is dependent upon the electron mobility and straggling effects in the gas. The choice of a resistor, therefore, reduces to one of selecting a value which, in combination with the input circuit to the linear amplifier, produces the best frequency response for amplifying the pulses. An additional factor that must be considered in determining the RC of the counter circuit is that of the gamma or beta background which may be present when alpha or proton pulses are being detected.

A high beta background imposes a limitation on the size of the resistor which can be used without decreasing the maximum alpha to the maximum beta pulse height ratio, (or the popularly called signal-to-noise ratio) because of inadequate resolution.[2] The importance of the counter and circuit capacity is discussed below.

Air counters possess relatively high resolution, i.e., better than 10^{-5} sec. The electron collection is much slower than in the case of certain pure gases, however, but the counter does show the characteristic of all proportional counters in that the avalanches are formed locally near the center-wire and do not spread. The pulse front formed is steep enough to require gain at moderately high frequency in the proportional amplifiers designed for them.

IV. INPUT CIRCUIT AND AMPLIFIER CHARACTERISTICS.

As mentioned above, the signal resistor is not critical. Values in the region of 1, 2 or 10 megohms are conveniently used with air counters in most applications. The amplifier need not be wide band, nor extend much beyond one megacycle in frequency response. Low frequency components below 10 K.C. do not appear to contribute appreciably to the shape of the puse, therefore, it is advantageous to provide low frequency suppression to remove microphonic difficulties and spurious electrical pick-up. An input sensitivity of an amplifier to a 2×10^{-3} volt pulse with a rising time of about 0.3 microsecond is satisfactory. This implies an amplifier gain of 200-400 if a pulse height selector which trips at about 0.5 volt is used.

It is evident that even with the maximum amplification factor for air the input pulses are the order of millivolts. The pulse size V_p depends upon the number of primary ion pairs n produced, the amplification factor $A(E)$ and the capacity of the counter C plus distributed capacity C' of input cables so that, if e is the unit charge,

$$V_p = \frac{-enA}{C + C'}$$

Usually $C' > C$. To improve the response and flatness of the operating region, the total capacity must be as small as possible because it permits even short range alpha or proton pulses to be recorded at operating potentials far below the beta threshold. When the total capacity is high the shortest range pulses continue to approach the recording level of the electronic circuit as the amplification factor is increased. This results in a steep slope on the counter characteristic curve. Figure 8 shows the result of adding 38μμ fd capacity (due to a coupling cable) to a proportional counter whose capacity is 41 μμ fd.

When air proportional counters must be used with a long connecting cable for survey measurements, it is essential to use a low-capacity concentric cable. Cables as long as 50 ft. have been used successfully. For general survey work inductive input networks or auto-transformers are not necessary. Where a high resolution is required such a circuit is necessary. The use of an amplifier or cathode-follower built into the survey probe also provides a solution to the difficulties found in using very long signal cables.

V. DESIGN OF AIR PROPORTIONAL COUNTERS.

The general principles outlined in the previous paragraphs make it possible to design extremely simple air counters to serve many purposes. All of the counters described below are based upon a concentric electrode system with certain modifications. Since a conventional proportional counter having, say, a 3 or 4 centimeter diameter cathode and a 3 or 4 mil center-wire, operates well above 3000 volts in the proportional region at one atmosphere, it is evident that two changes in the geometry can be made to shift the operating potential by 500 to 1200 volts downward. Since the amplification factor increases with a decrease in the wire diameter, and the useful amplification factor is, as stated above, limited by photon production, then the center-wire should be made as small as consistent with mechanical strength and freedom from sharp bends in the wire. This infers wire diameters of the order of 1 mil or less. Since it is desirable to reduce the number of negative ions formed in the counter volume and to increase the field gradient in the region of the center-wire, small diameter cathodes are required. The length of proportional air counters is not important except for the effect of the added capacity on the pulse shape and size.

Figure 7 illustrates a counter having a wire mesh screen for a cathode whose diameter is 2 inches. This counter has been used for detection of alpha contamination on hands and apparatus. With a center-wire diameter of 2 mils, the proportional threshold was approximately 3050 volt with an operating region near 3500 volts. With a center-wire diameter of 1 mil, the threshold was 2375 volts, and the operating region occurred near 2800 volts. The pressure was 76 cm. Hg. The measurements were made with an input sensitivity of 1.5 millivolts calibrated by means of a pulse generator with a pulse rise time of about 0.3 microsecond and a base pulse width of 1.5 microsecond. The amplifier response was essentially flat from 10^4 C.P.S. to 10^6 C.P.S.; a signal resistor of 5×10^6 ohms was used. The slope of the operating region was 0.23% rise of counting-rate per volt change in operating potential when a cable having appreciable capacity to ground is used to simulate actual probe operating conditions.

Since the field intensity in the region of the cathode is very low, considerable distortion of the cathode can be produced without changing the electrical characteristics around the center-wire appreciably. Therefore, a longitudinal flattening of a conventional counter is practical and is by now common practice (CP-1527). Several applications of this can be made in counters designed for contamination survey work where high sensitivity is desirable.

Figure 3 illustrates a counter of this type. A portion of the cathode surface has been removed. The center-wire has been moved off center far enough so that the field distribution is considerably distorted to produce a field distribution that permits increased positive ion collection around the solid portion of the cathode. The open window can be covered by cementing (Type 3-M Cement) a thin, aquadag-coated nylon film to the counter body. These counters are used extensively in general survey work. The smaller unit shown in Figure 4 is useful in checking contamination inside chemistry glassware.

Small metallic feet or guards are provided to protect the nylon film from being torn--especially on sharp corners. The center-wire is 1 mil in diameter and the operating potential at 76 cm. Hg. pressure is about 2200 volts. The probe in Figure 4 has an operating potential of about 2100 volts. These data are given for a 2 millivolt input sensitivity. The connecting cable was about 10 feet long with a total capacity of 220-260 $\mu\mu$ fd.

A method of calibration for these probes, when used in survey instruments to measure disintegration rates, is described in Appendix I.

In order to increase the exposed area for detection, another design, based on the above counter, has been adopted. Cross-section views and the assembly of the unit are clear from Figure 5. Each center-wire is electrically shielded from the other wires by ridges in the cathode as shown. However, these ridges do not project far enough to interfere with oblique alpha trajectories extending from the open cathode side. An open mesh screen or thin-conducting window is generally used to complete the cathode surface in this type of counter. The local sensitivity of such a counter is remarkably constant over the entire exposed surface. This has been verified by using a collimated alpha beam. With tiny supporting feet the counter gives reproducible data over a wide variety of flat surfaces which are contaminated.

In Report LA-73, a multiple grid was used in the proportional region for the measurement of proton ranges. Another type of counter with parallel multiple wires, having parallel cathodes is shown in Figure 6 which deviates considerably in field distribution and construction from that described in LA-73. One of the parallel plates can be an open-mesh screen to admit alpha radiation or may be some other type of thin window. A general criterion for the proper design of this counter is that $b \approx 2a$ where __a__ is the distance between parallel plates and __b__ is the distance between center-wires. This provides a more satisfactory field distribution for ion collection and reduces the operating potential of the multiple wire system. Figure 8 illustrates the characteristic curve of the counter with a 38$\mu\mu$ fd. cable attached. Figure 8 also shows the characteristic curve of the 10-wire counter without a long cable. The 1 mil tungsten wires are spaced 1/2" apart by polystyrene insulators. The wires have small silver solder beads on either end for making contact with the spring and the insulator. (MUC-JAS-56 or CP-2852, Appendix III.) This prevents sharp points from producing spurious effects. The operating potential at 76 cm. Hg., air pressure with cables is approximately 2250 volts with a 100 volt operating region.

The sensitive surface is 5"x10", and the topographical distribution of counting yield is given in Figure 9, with the highest value indicated as unity. A collimated source of alpha particles was used to determine the local yield. With a 0.2 mil nylon screen which has a thin, translucent layer of aquadag, the counting yield is about 20% of the counting-rate of a spread sample as compared with a measurement in a parallel plate chamber.

Whenever it is necessary to search for alpha activity in difficult positions or in the outer passages of the human nose, the counter shown in Figure 10 may be helpful. The outer cathode surface is merely four heavy parallel rods; the center-wire is installed equidistant from each of them. For some applications, the dimensions can be reduced by a factor of 2 or 3. By removing the connector assembly and wrapping 0.5 mg/cm^2 nylon (aquadag-coated) around the unit, it can be used in conjunction with a bronchia-scope. By only using platinum, glass and tungsten in the counter construction it is possible to sterilize the unit after each use.

Figure 13 shows the construction of a symmetrical alpha counter for measuring contamination in beakers. The counter illustrated in Figure 14 utilizes a center-wire in the form of a loop lying in a plane perpendicular to the aquadag-coated thin window. The operating potential can be adjusted by sliding the large insulator which supports the center-wire assembly. The sensitive area of the counter coincides with the geometrical area of the window. This counter is rugged mechanically and possesses a high counting yield. Figure 15 describes a long probe counter which incorporates many mechanical advantages not found in the one shown in Figure 3.

VI. WINDOWS FOR ATMOSPHERIC PRESSURE COUNTERS.

Wire screens having 80% transmission have been widely used in air counters, but the disadvantage of dust accumulating in the high field regions inside the counter along with contamination problems has made it imperative to find dust barriers for all but the simplest types of counter probes. One of the most useful thin windows is sheet nylon plastic.[4] It possesses great mechanical strength and can be stretched into very thin films as low as 0.1 mg. per cm^2. Nylon film 0.2 mil thick is 0.56 mg/cm^2 and has been prepared commercially. The film can have its molecules oriented by proper stretching, so as to decrease thickness and increase strength. It possesses the disadvantage, already mentioned, of having a high water vapor permeability--which is approximately 4200 gms. per 100 square meters of surface per hour for 0.2 mil nylon. In contrast with this, the permeability of saran-coated cellophane is 50. Many types of coatings were applied to the thin nylon, but none have been found which work satisfactorily. Zapon, glyptal, silicones and varnish have been tried, among many others. Not more than a factor of 10 could be obtained in decreasing the vapor transmission of the film. In all cases, the total thickness of window and coating must be kept to a minimum.[5]

Using 0.2 mil nylon film, the following water vapor

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4. This film was introduced some time ago by C. Borkowski for use on ion and vacuum chambers.
5. H.S.Turner has suggested the use of vinylidene chloride polymers on nylon film. In particular, the vinylidene chloride acrylenitrile copolymers of the Dow Chemical Company, which are soluble, may be used.

transmission measurements[6] were made by H. S. Turner of the DuPont Company. All samples were prepared with only one side coated.

Sample	Coating.	Transmission in gms/100 sq. meters/hr.
#5	Zapon, thinned	1980
#8	Aquadag	1340
#11	Dow-Corning silicone	1340
#12	Control. No coat	4170

It should be pointed out that these measurements, to some extent, depend upon the previous history of the films and from what side of the film the water vapor transmission is made. For example, a very dry film may have a low measured transmission, whereas one that previously has acquired moisture may show a high vapor transmission.

Polyvinyl butyral (Butacite) has been tried, but its gas permeability is very high. Saran and cellophane films have been unsatisfactory because of their high density and the fact that they are not made thin enough commercially.

A satisfactory window having a high <u>alpha</u> particle transmission is aquadag-coated[7] 0.2 mil nylon. The coating is translucent and measures 3000 ohms between the center and frame of a 5"x10" window. To check alpha transmission, a collimated alpha source was used to determine the counting-rate as a function of the sample distance from the counter. At first, uncoated nylon was used to obtain Curve #1 in Figure 11; the usual 4-mesh stainless steel screen was in place 1/8" from the nylon. (A small electrostatic charge can be built up on the insulated surfaces of this film. This has been demonstrated by using charged bodies near the surface to produce spurious counts.) After Curve #1 had been determined, the film was sprayed with aquadag, as mentioned above, and Curve #2 in Figure 11 was determined. The results indicate that an increase in field intensity near the film, due to a conducting surface, improves the counting yield in spite of the fact that the absorption has been increased. Also it can be seen from the flattening of the two curves, that within a distance of 1 cm. from the film essentially all the alpha particles from the beamed source are being counted.

The 10-wire flat counter has been adapted to determine alpha contamination on hands. This application has uncovered

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6. Church and Scroggie, Paper Trade Journal Oct. 3, 1935, p.3.
7. See CP-2852, Appendix IV, for techniques of application.

[redacted]

water vapor difficulties. As already mentioned, the face of the counter is covered with 0.2 mil aquadag-coated nylon film over which is placed an open-mesh protective screen. The nylon will not act as a barrier to moisture and may absorb 2-3% of its own weight in water vapor. Thus when a warm, and perhaps moist, hand is placed near the film water vapor may enter the counter volume where it may condense on cool surfaces. Among such cool surfaces are the insulators and, if they are not perfect (free from dirt and scratches), the surface resistance will rapidly change. It usually requires 1-2 minutes with a hand on a counter to produce such an effect--the end result of which is a high, spurious background. After removal of the hand, the counter will return to normal within 30-40 seconds. Obviously, the time for such an effect to become noticeable in a counter depends upon the window permeability to water, the relative humidity, the temperature of the surfaces and the surface conditions of the insulators. All of these difficulties have been bypassed by providing a 12-watt electric heating unit mounted on the counter back plate.[8] This runs at 41°-45° C. Under such condition, no spurious effects can be detected even at 100% relative humidity. The counter is almost cool on the top side where the hand is located.

The author wishes to thank Mr. Jerome Brewer for his invaluable help in collecting and plotting the data on the hand counters, pressure and temperature curves and nylon film transmission.

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8. The details of this method were worked out by E.H.Wakefield.

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APPENDIX I.

CALIBRATION OF ALPHA SURVEY PROBES.

The single wire, long survey probes discussed in this report present some difficulties in calibration. It is easy to determine the counting yield from a point source placed symmetrically under the window. Difficulties arise when an extended source is measured on, say, a flat surface. In this case the probe position over the active region may be quite critical for obtaining reproducible results. If such reproducibility is necessary, a wide area probe should be used instead. The characteristics of the latter type have been given.

Since atmospheric pressure conditions are continually changing, the most satisfactory method for calibrating a probe is to use a standard alpha sample mounted on a small portable frame that can be attached to the probe to give a reproducible geometry for calibration purposes.

Figure 12 shows an adaptable unit used for Model 7a (Figure 3) probes. By using only the bottom plate in which the sample is mounted flat probes can be calibrated. It is helpful to spray the sample with Zapon dissolved in ether to protect the sample. The coating thickness should be equivalent to not more than 0.1 mg/cm^2 to avoid absorption.

The large flat counters (Model 10B) used for detecting alpha contamination on hands can be calibrated by using a sample recessed 30-40 mils in a large metal block. The edge of this block should have small hooks which can catch on the wire mesh of the counter. The weight of the block will keep the sample uniformly pressed close to the screen. (CP-2852, Appendix I).

[redacted]

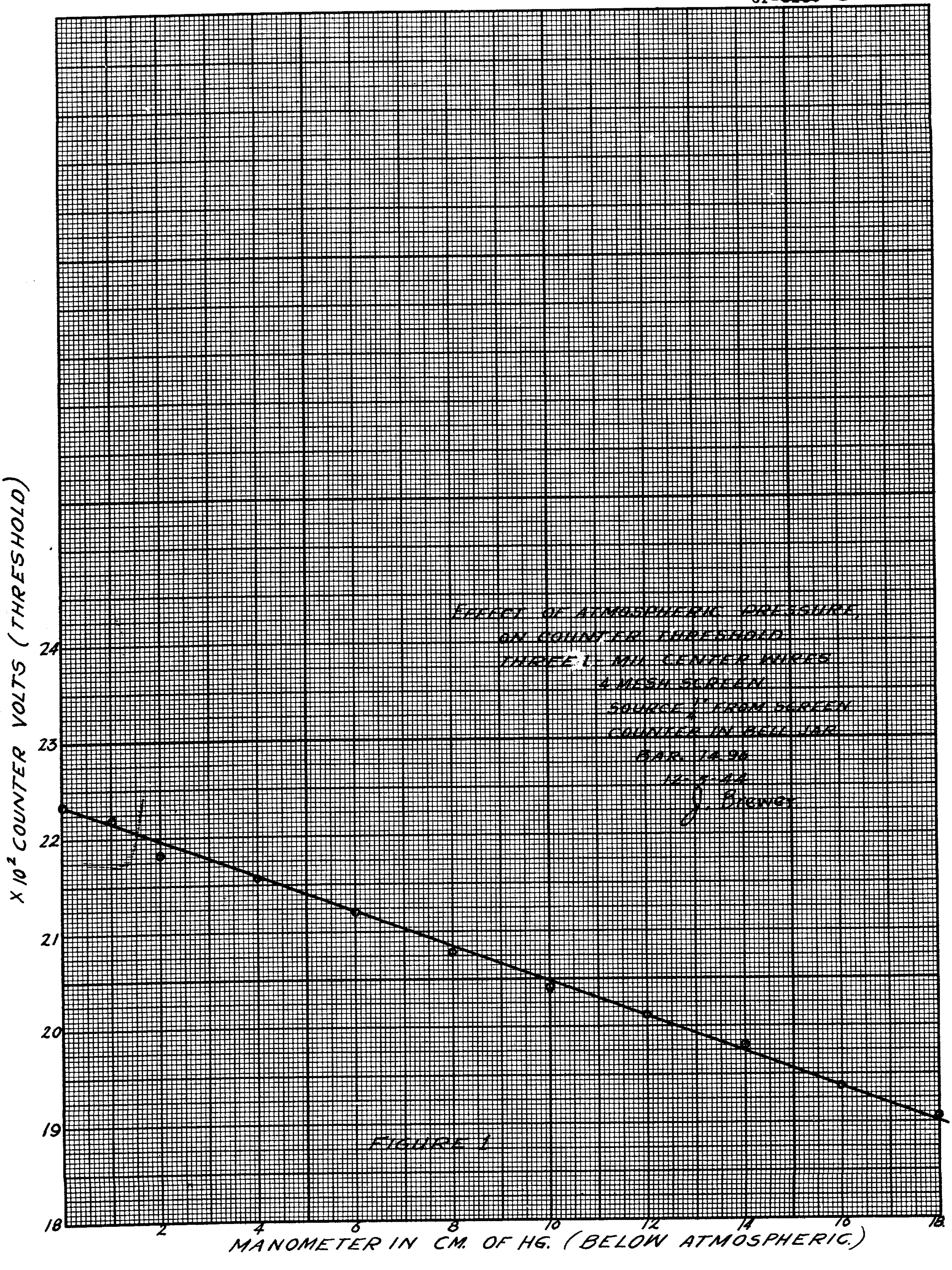

EFFECT OF ATMOSPHERIC PRESSURE,
ON COUNTER THRESHOLD
THREE 1-MIL CENTER WIRES
4 MESH SCREEN
SOURCE 1/4" FROM SCREEN
COUNTER IN BELL JAR
BAR. 14.96
12-5-42
J. Brewer
$\times 10^2$ COUNTER VOLTS (THRESHOLD)
24
23
22
21
20
19
18
2
4
6
8
10
12
14
16
18
MANOMETER IN CM. OF HG. (BELOW ATMOSPHERIC)

FIGURE 1

CP-2857

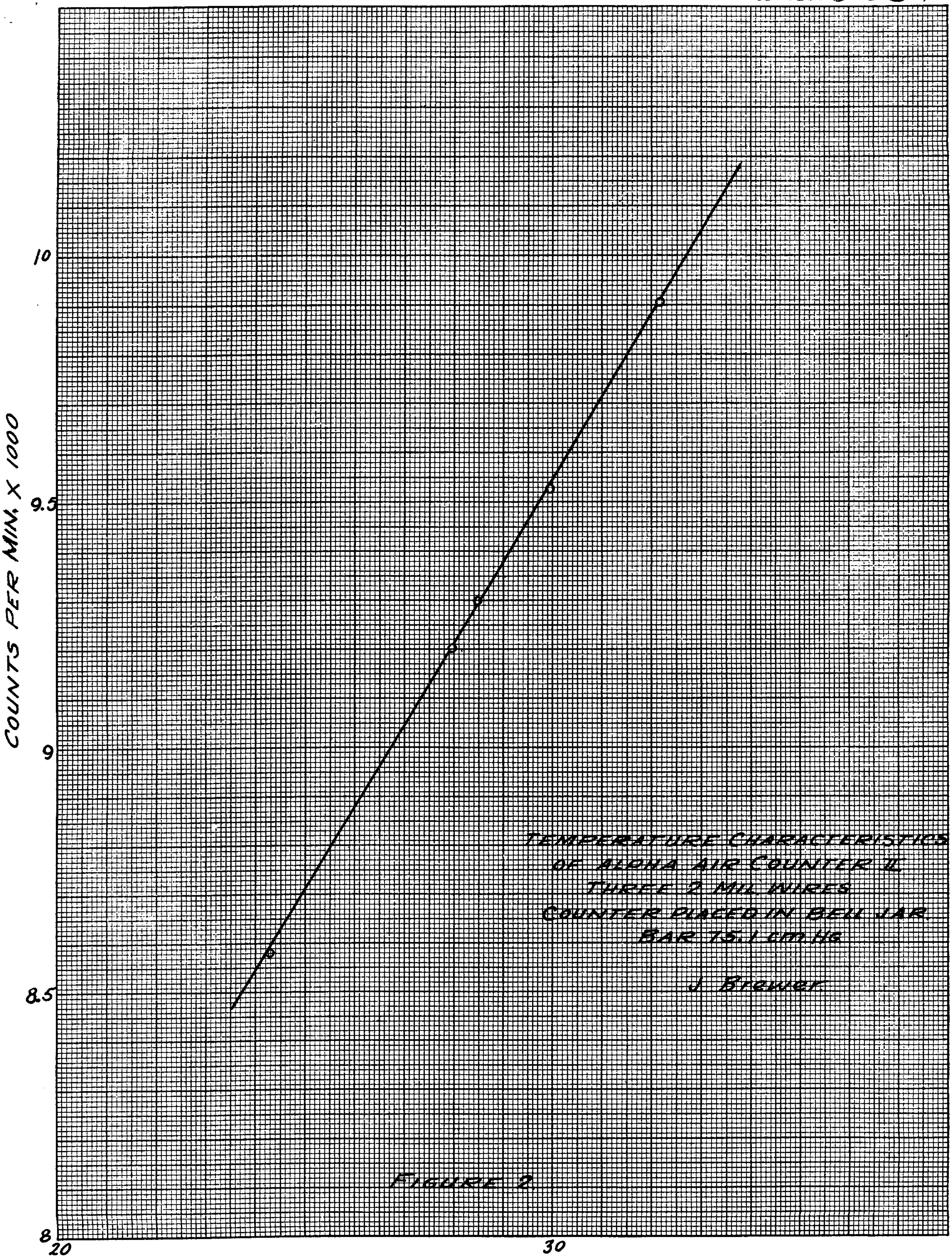
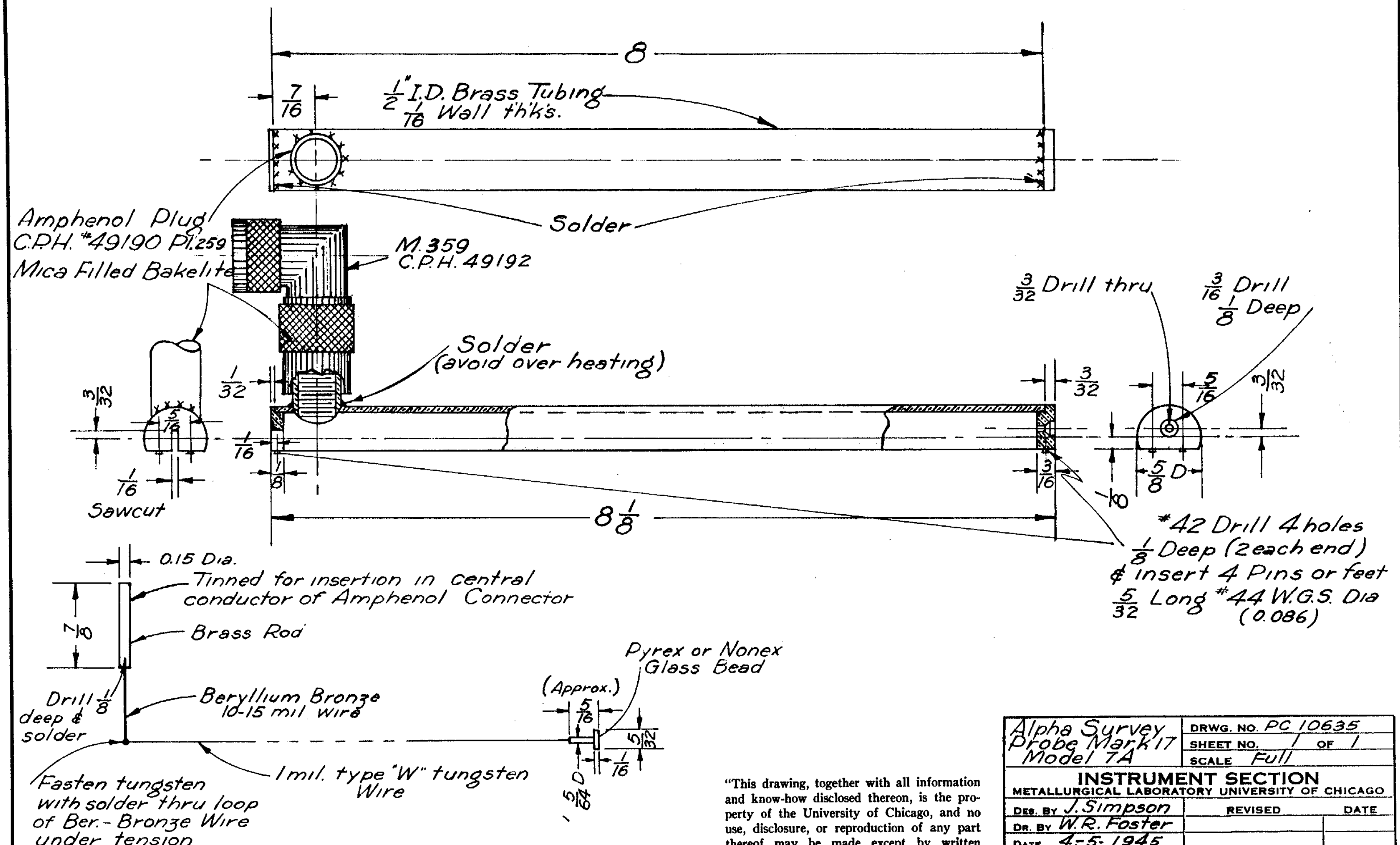


FIGURE 2

COUNTER TEMPERATURE IN DEGREES CENTIGRADE cp-~~3757~~ 2851

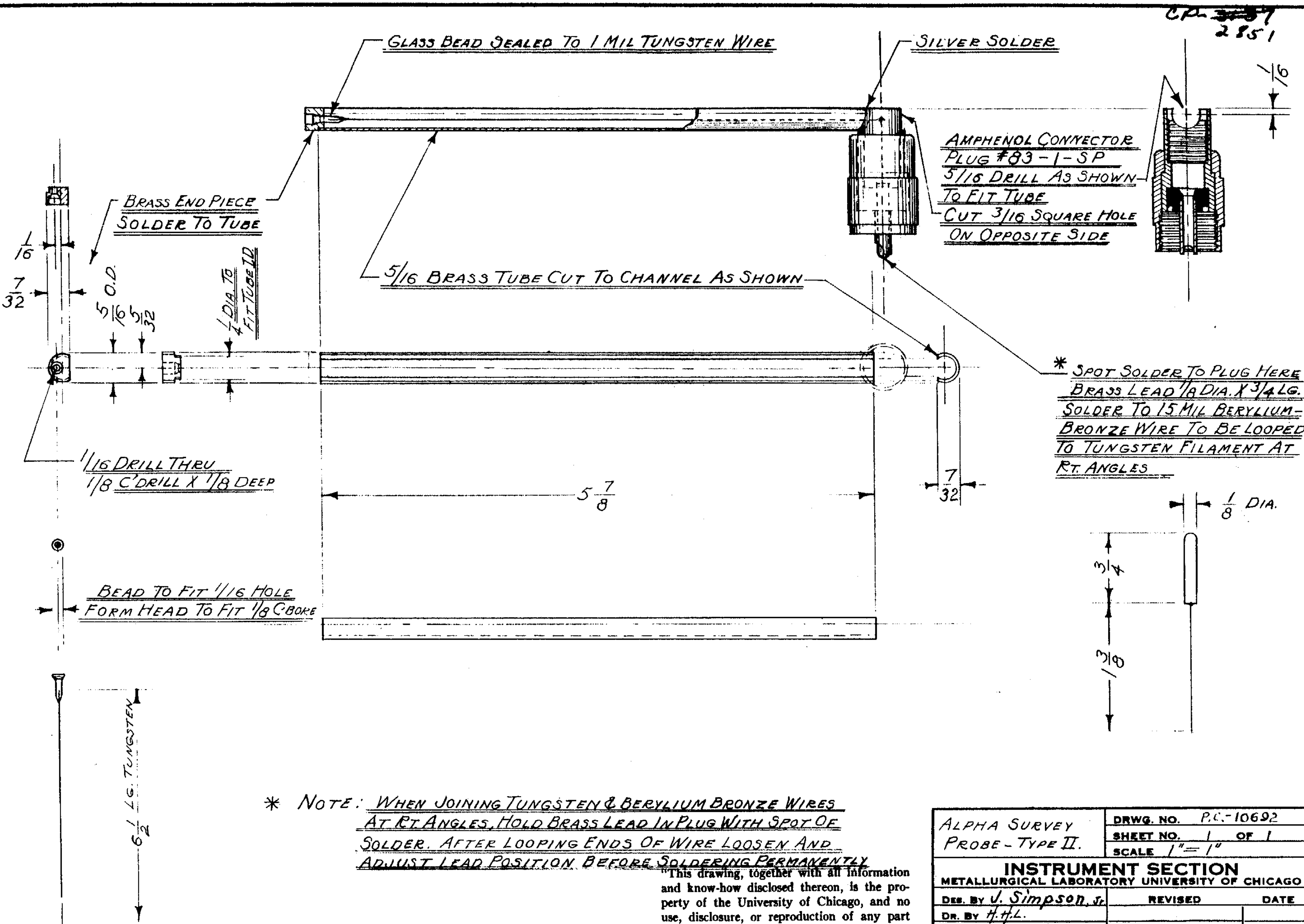


"This drawing, together with all information and know-how disclosed thereon, is the property of the University of Chicago, and no use, disclosure, or reproduction of any part thereof may be made except by written authorization of the University of Chicago."

Alpha Survey Probe Mark 17 Model 7A	DRWG. NO. PC 10635	
	SHEET NO. 1 OF 1	
	SCALE Full	
INSTRUMENT SECTION METALLURGICAL LABORATORY UNIVERSITY OF CHICAGO		
DES. BY J. Simpson	REVISED	DATE
DR. BY W.R. Foster		
DATE 4-5-1945		
APP. BY J. Simpson		

41882—144—8-44

Figure 3



* NOTE: WHEN JOINING TUNGSTEN & BERYLIUM BRONZE WIRES AT RT. ANGLES, HOLD BRASS LEAD IN PLUG WITH SPOT OF SOLDER. AFTER LOOPING ENDS OF WIRE LOOSEN AND ADJUST LEAD POSITION BEFORE SOLDERING PERMANENTLY

ALPHA SURVEY PROBE - TYPE II.	DRWG. NO. P.C.-10692	
	SHEET NO. 1 OF 1	
	SCALE 1" = 1"	
INSTRUMENT SECTION METALLURGICAL LABORATORY UNIVERSITY OF CHICAGO		
DES. BY J. Simpson, Jr.	REVISED	DATE
DR. BY H.H.L.		
DATE 5-2-45		
APP. BY —		

41883—144—6-44

Figure 4

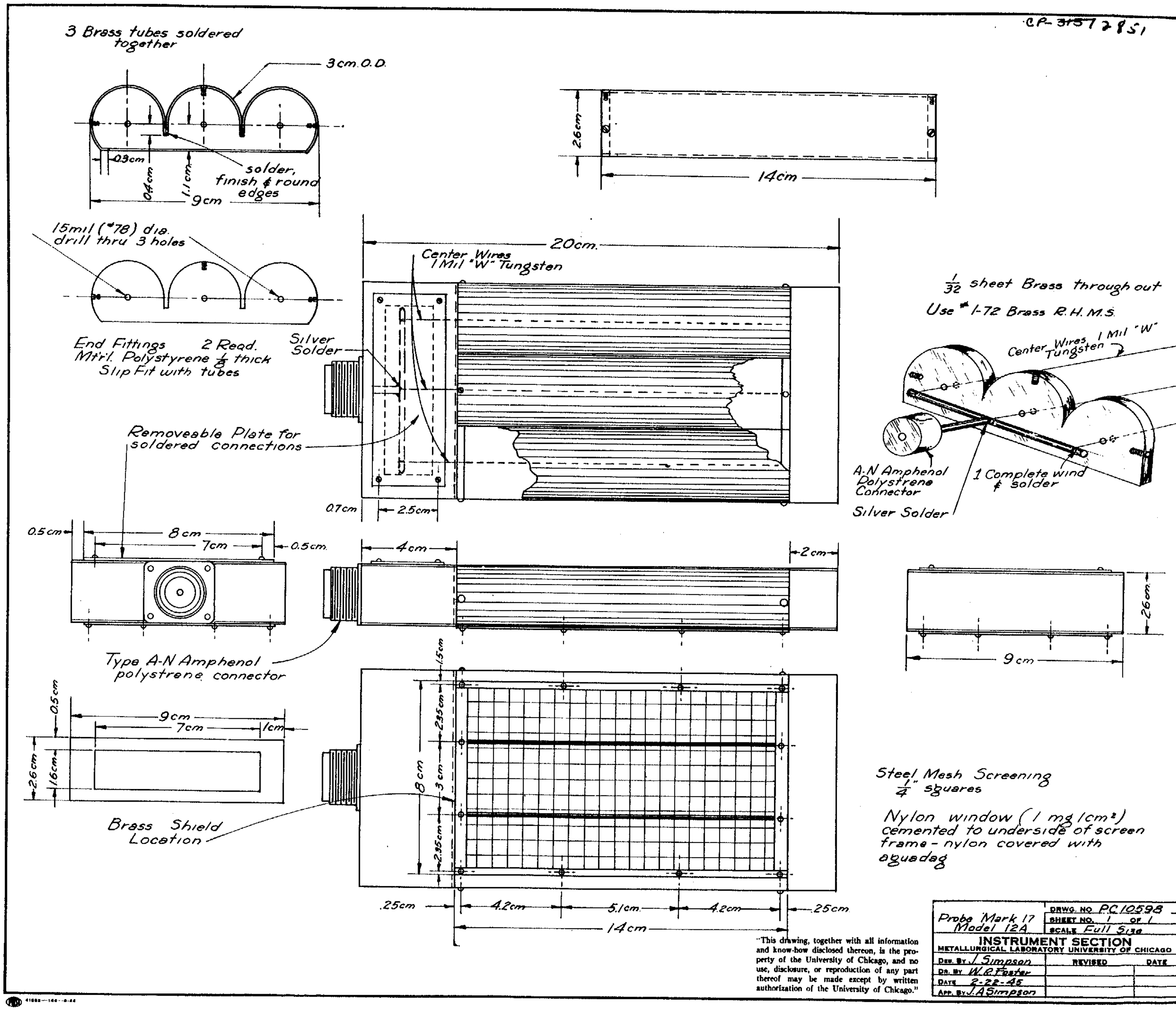
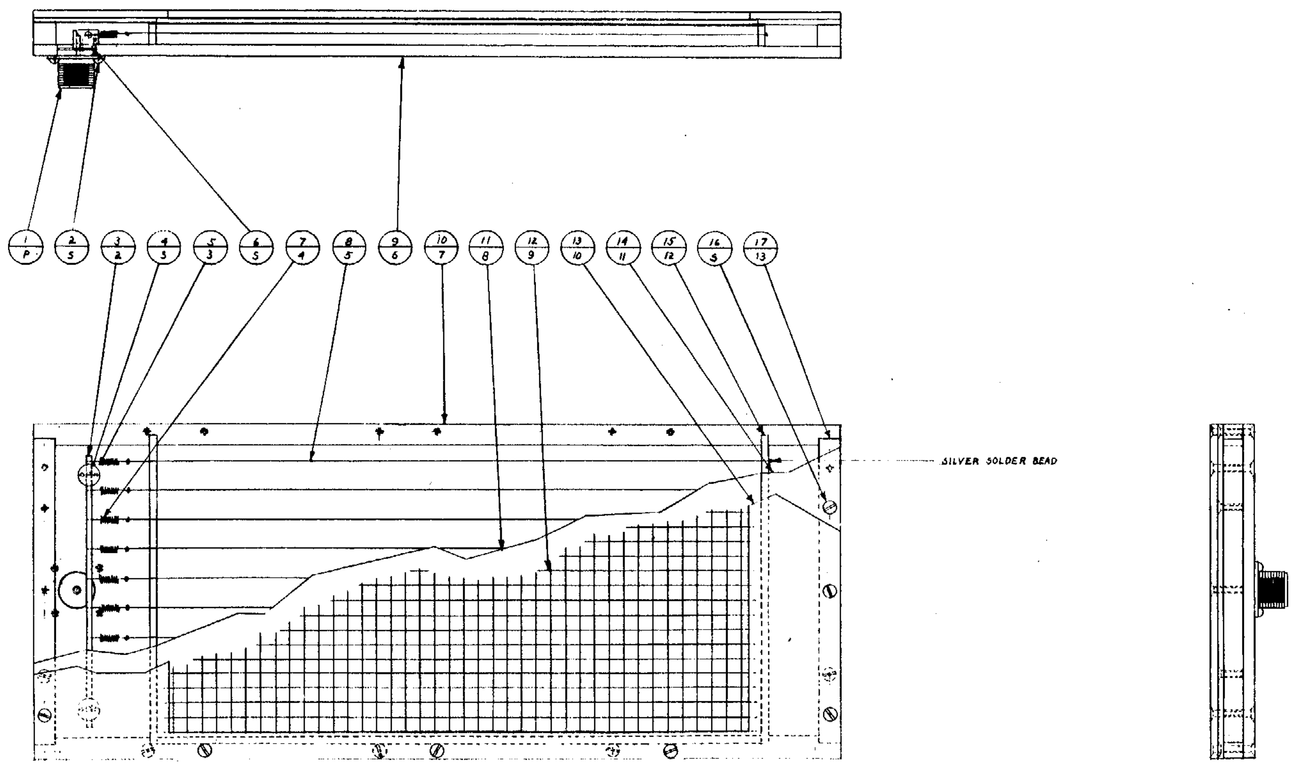

CP-3157 2851
3 Brass tubes soldered together
3cm. O.D.
0.3cm
0.4cm
1.1cm
solder, finish & round edges
9cm
2.6cm
14cm
15mil (#78) dia. drill thru 3 holes
20cm.
Center Wires 1 Mil "W" Tungsten
1/32 sheet Brass through out
Use #1-72 Brass R.H.M.S.
Center Wires 1 Mil "W" Tungsten
End Fittings 2 Read. Mtr'l. Polystyrene 1/8 thick Slip Fit with tubes
Silver Solder
Removeable Plate for soldered connections
A-N Amphenol Polystrene Connector
1 Complete wind & solder
Silver Solder
0.7cm
2.5cm
0.5cm
8cm
7cm
0.5cm.
4cm
2cm
26cm
9cm
Type A-N Amphenol polystrene connector
1.5cm
2.35cm
3cm
8cm
2.35cm
0.5cm
9cm
7cm
1cm
2.6cm
1.6cm
Brass Shield Location
Steel Mesh Screening 1/4" squares
Nylon window (1 mg/cm²) cemented to underside of screen frame - nylon covered with aquadag
.25cm
4.2cm
5.1cm
4.2cm
.25cm
14cm
"This drawing, together with all information and know-how disclosed thereon, is the property of the University of Chicago, and no use, disclosure, or reproduction of any part thereof may be made except by written authorization of the University of Chicago."
Probe Mark 17 Model 12A
DRWG. NO. PC10598
SHEET NO. 1 OF 1
SCALE Full Size
INSTRUMENT SECTION
METALLURGICAL LABORATORY UNIVERSITY OF CHICAGO
DES. BY J. Simpson
DR. BY W.R. Foster
DATE 2-22-45
APP. BY J.A. Simpson
REVISED
DATE

Figure 5

GP-~~2124~~
2851

DET	QUAN	DESCRIPTION		MATERIAL	SH
1	1	CONNECTOR	AMPHENOL #83-1RY	POLYSTYR	P
2	4	SCREW	#4-36 X 1/4 RH	BRASS	5
3	2	ROD	3/32 DI X 7/8	BRASS	2
4	4	SCREW	#1-72	BRASS	5
5	2	INSULATOR	3/8 DIA X 5/16	POLYSTYRE	3
6	4	SCREW	#3-56 X 5/16	BRASS	5
7	10	SPRING	.010 X 3 3/4	MUSK WIR	4
8	10	WIRE	.001 X 11	TUNGSTEN	5
9	1	BASE	3/16 X 5 3/4 X 13 7/8	BRASS	6
10	2	SIDE	3/8 X 3/8 X 13 7/8	BRASS	7
11	1	SCREEN	.0002 X 5 3/4 X 13	NYLON	8
12	1	SCREEN	1/4 MESH X .025	STAINLESS S	9
13	1	UPPER FRAME	1/8 X 5 3/4 X 13 7/8	BRASS	10
14	1	FRAME	3/32 X 5 3/4 X 13 7/8	BRASS	11
15	2	RACK	1/8 X 3/8 X 5 3/8	POLYSTYRE	12
16	32	SCREW	#3-48 X 1/8	STAINLESS	5
17	2	END	3/8 X 3/8 X 5 1/4	BRASS	13



ALL PARTS MUST BE INTER-CHANGEABLE

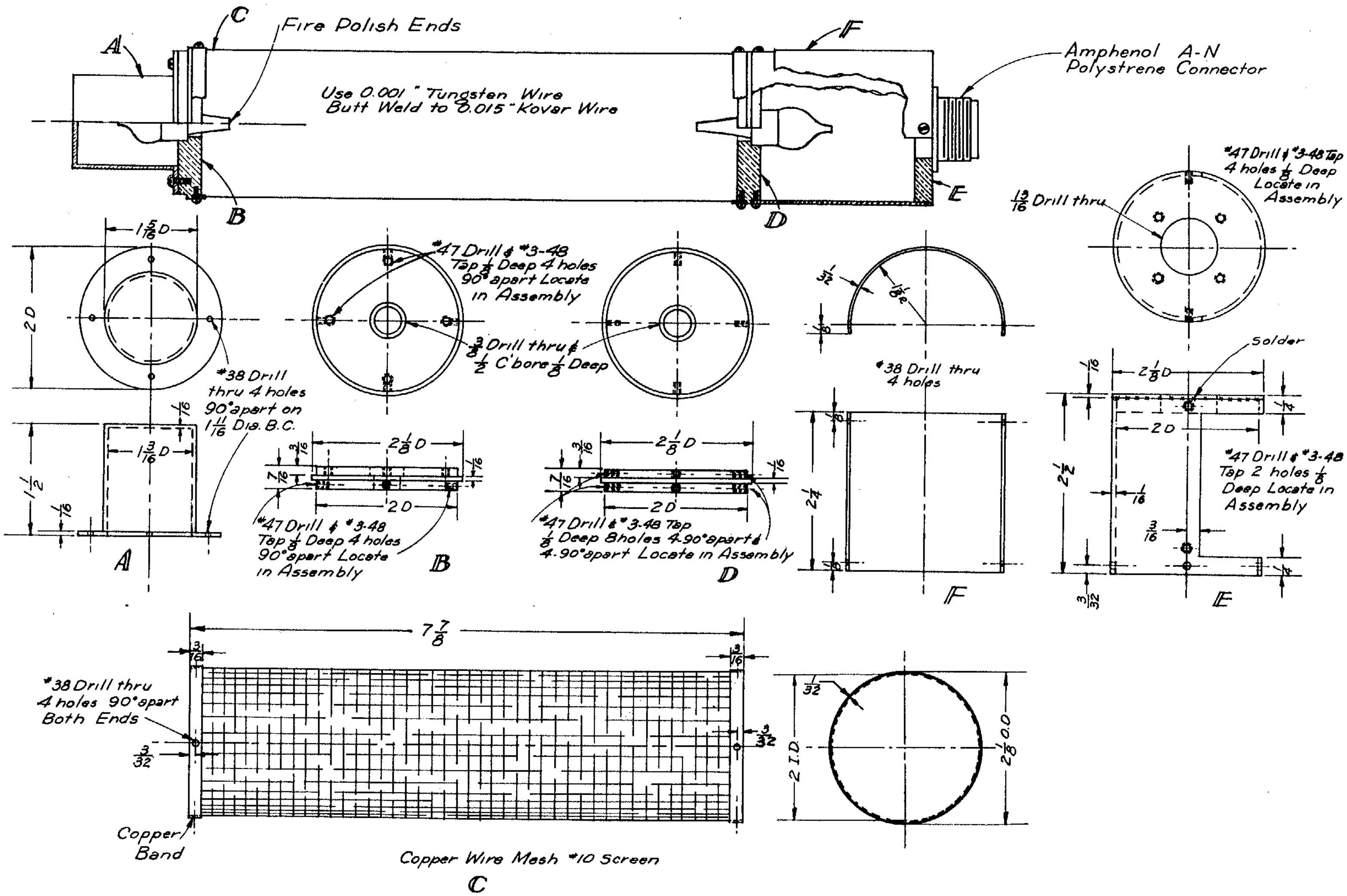
MARK 17 MODEL 108 TYPE A	DRWG NO PM 10625 SHEET 1 OF 10 SCALE FULL

INSTRUMENT SECTION
METALLURGICAL LABORATORY UNIVERSITY OF CHICAGO

	REVISED	DATE
DEL BY J. Simpson Jr.	SCREWS ELIMINATED	5-9-45
DR BY GH 4-27-45	NEW MODEL NO.	5-25-45
DATE		
APP BY		

Figure 6

CP-2851



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Cylindrical Alpha Counter Mark 17, Model 11A	DRWG. NO. PC 10636	
	SHEET NO. 1 OF 1	
	SCALE Full	
INSTRUMENT SECTION METALLURGICAL LABORATORY UNIVERSITY OF CHICAGO		
DES. BY J. Simpson	REVISED	DATE
DR. BY W. R. Foster		
DATE 5-7-45		
APP. BY J. A. Simpson		

Figure 7

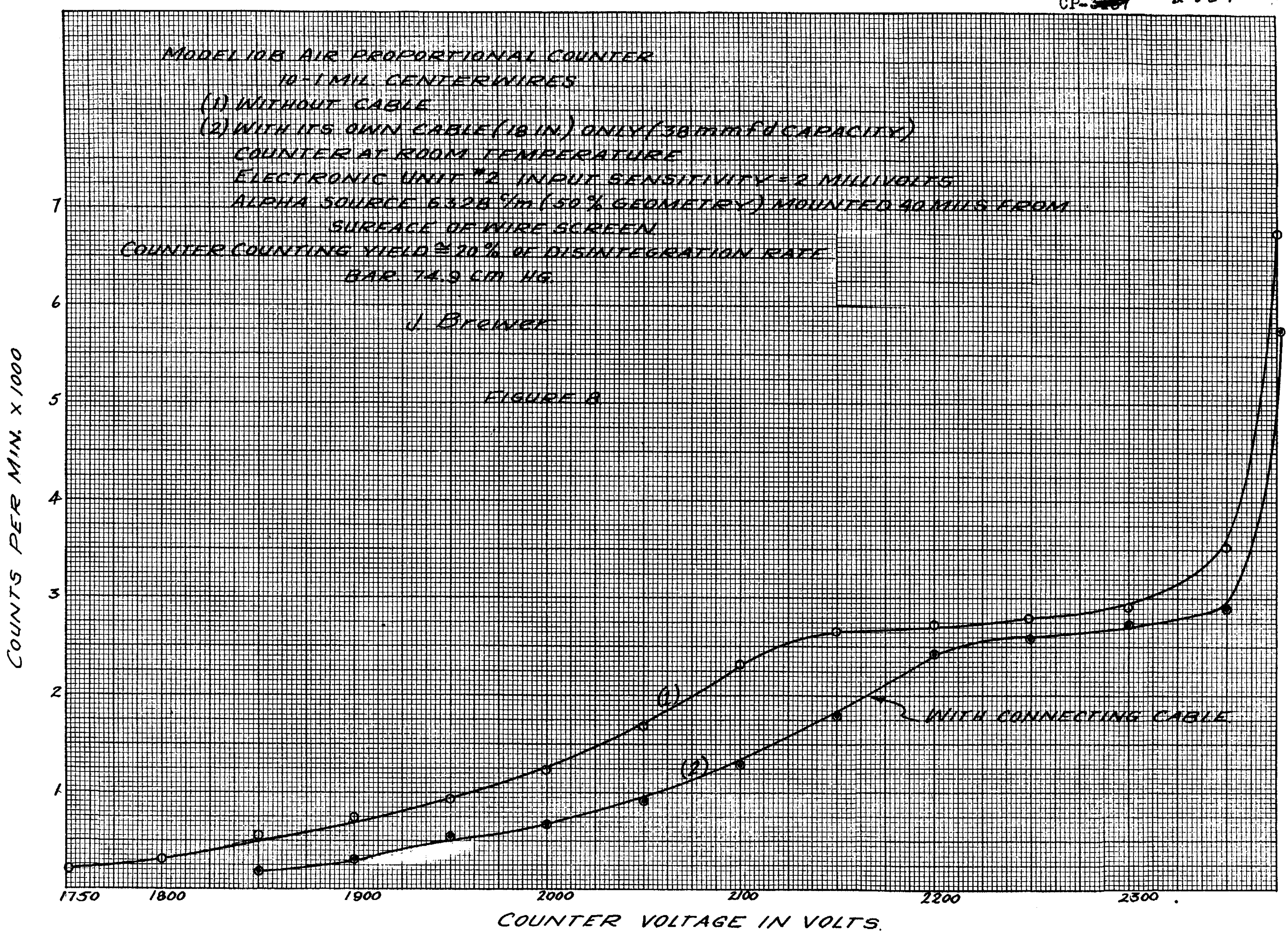
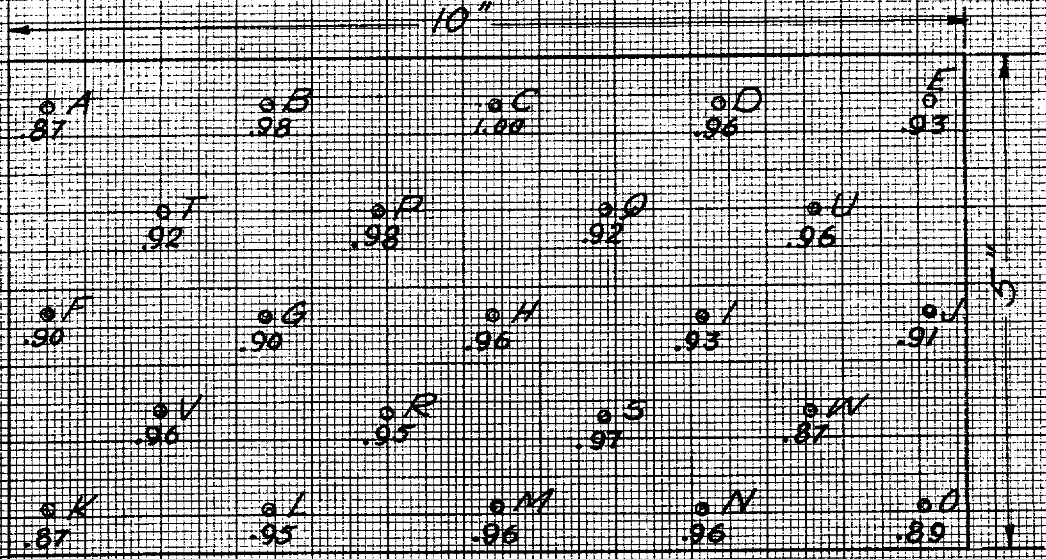

MODEL 10B AIR PROPORTIONAL COUNTER
10-1 MIL CENTERWIRES
(1) WITHOUT CABLE
(2) WITH ITS OWN CABLE (18 IN) ONLY (38 mmfd CAPACITY)
COUNTER AT ROOM TEMPERATURE
ELECTRONIC UNIT #2 INPUT SENSITIVITY = 2 MILLIVOLTS
ALPHA SOURCE 6328 c/m (50% GEOMETRY) MOUNTED 40 MILS FROM
SURFACE OF WIRE SCREEN
COUNTER COUNTING YIELD ≅ 20% OF DISINTEGRATION RATE
BAR. 74.9 CM HG.
J. Brewer
(1)
(2)
WITH CONNECTING CABLE
COUNTS PER MIN. x 1000
1
2
3
4
5
6
7
1750
1800
1900
2000
2100
2200
2300
COUNTER VOLTAGE IN VOLTS.

FIGURE 8

CP-2851



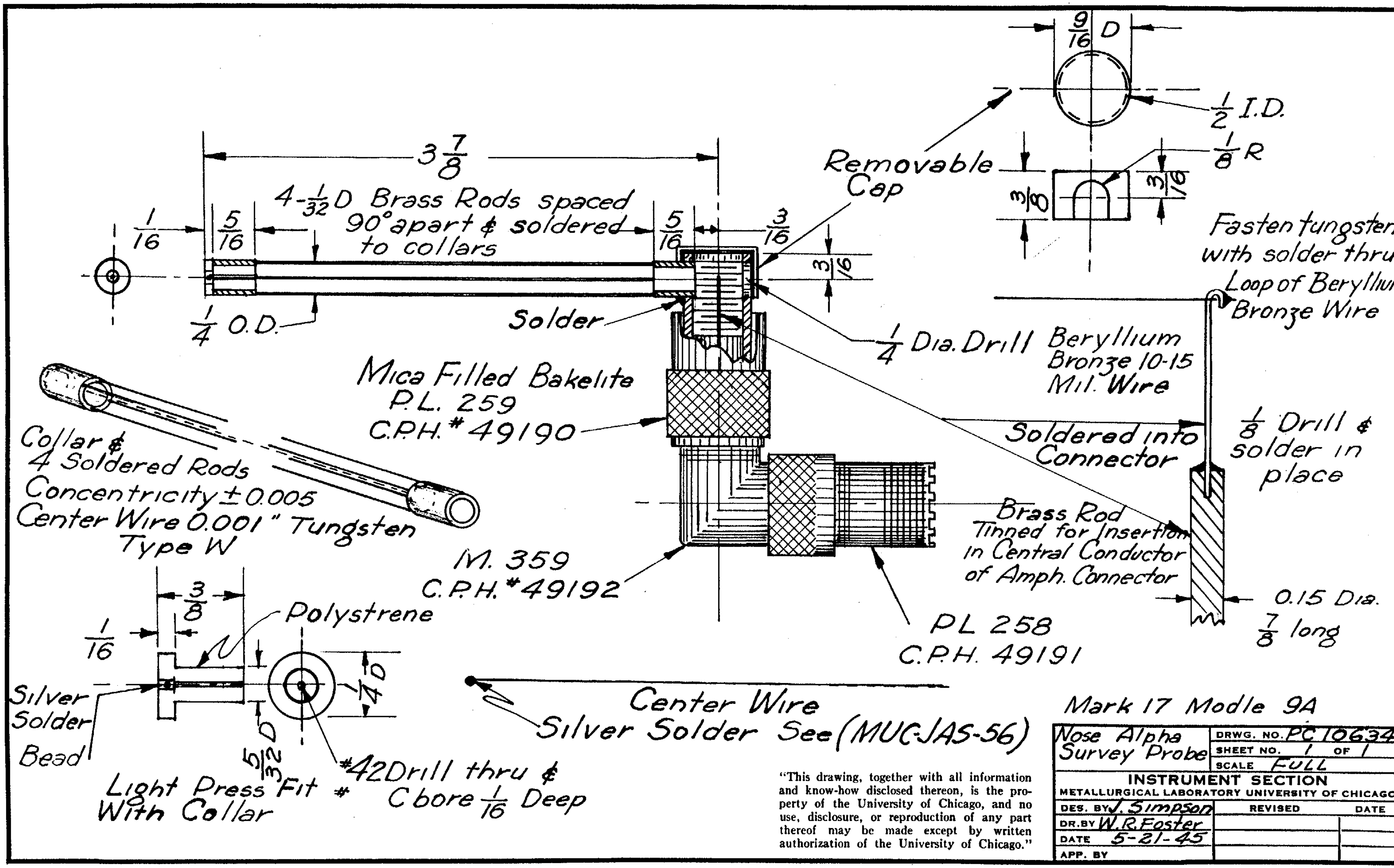
SCALE 1/4 SIZE OF SENSITIVE COUNTER AREA

RELATIVE TOPOGRAPHICAL VARIATIONS OF SENSITIVITY
OF COUNTER #3 MODEL 10B, 10 WIRES
PRODUCTION MODEL
ELECTRONIC UNIT SERIAL #2
COLUMNATED BEAM OF ALPHA
PARTICLES - SOURCE 0.5 cm FROM COUNTER
COUNTER VOLTAGE - 2235 VOLTS, 20 VOLTS BELOW GAMMA
THRESHOLD

J. BREWER

FIGURE 9

CR-[redacted] 2851



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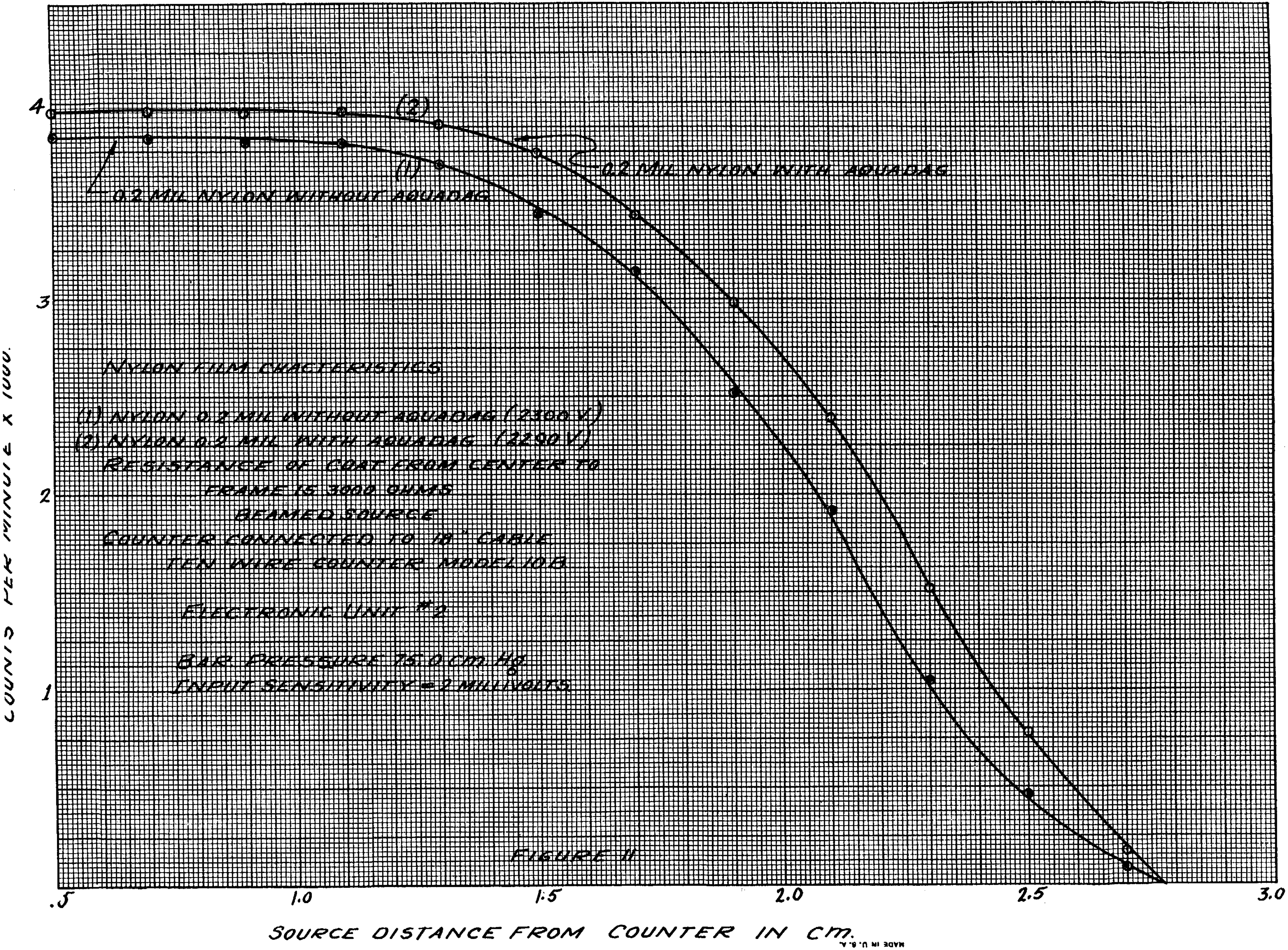
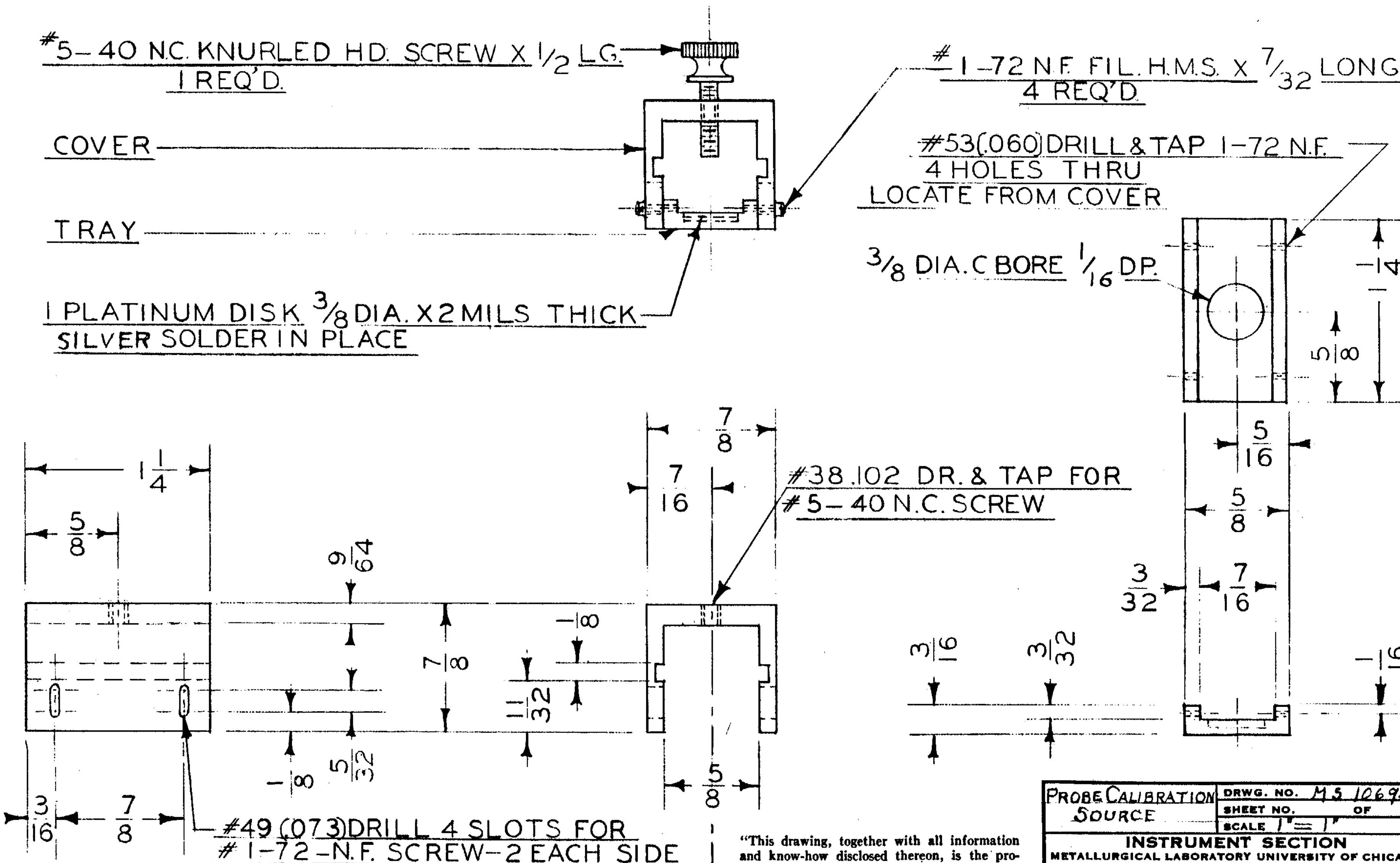
42478—144—9-44

Figure 10



4
3
2
1
.5
1.0
1.5
2.0
2.5
3.0
COUNTS PER MINUTE X 1000.
SOURCE DISTANCE FROM COUNTER IN cm.
(2)
(1)
0.2 MIL NYLON WITH AQUADAG
0.2 MIL NYLON WITHOUT AQUADAG
NYLON FILM CHACTERISTICS
(1) NYLON 0.2 MIL WITHOUT AQUADAG (2300 V)
(2) NYLON 0.2 MIL WITH AQUADAG (2290 V)
RESISTANCE OF COAT FROM CENTER TO
FRAME IS 3000 OHMS
BEAMED SOURCE
COUNTER CONNECTED TO 18" CABLE
TEN WIRE COUNTER MODEL 10B
ELECTRONIC UNIT #2
BAR PRESSURE 75.0 cm. Hg
INPUT SENSITIVITY = 2 MILLIVOLTS
MADE IN U.S.A.

FIGURE 11



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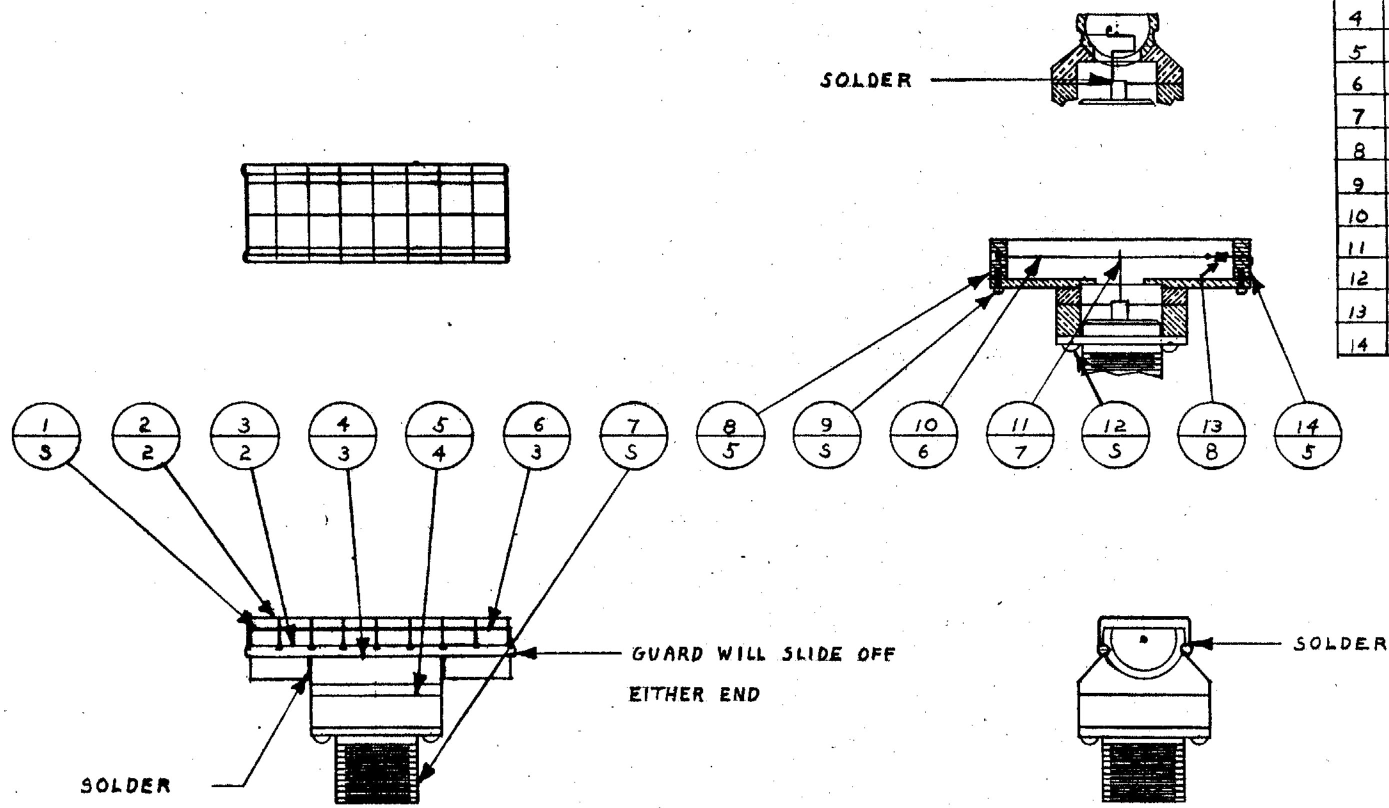
PROBE CALIBRATION SOURCE	DRWG. NO. MS 10695		
	SHEET NO.	OF	
	SCALE 1" = 1"		
INSTRUMENT SECTION METALLURGICAL LABORATORY UNIVERSITY OF CHICAGO			
DES. BY J. Simpson	REVISED		DATE
DR. BY H.H.L.			
DATE 5-1-45			
APP. BY			

Figure 12

CP 2851
Fig. 13

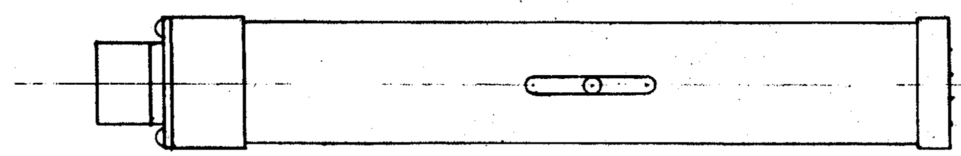
DET.	QUA	DESCRIPTION		MAT'L.	SH
1	1	SCREEN	.0002	NYLON	5
2	1	GUARD	.025X¼ MESH	ST. STEE	2
3	2	SLIDE	3/32 DIAX2	BRASS	2
4	1	CRADLE	1X1X 5/16	BRASS	3
5	1	BASE	1X1X 1/4	BRASS	4
6	1	TUBE	5/8 DIAX2	BRASS	3
7	1	CONNECTOR	83-1RY	POLY.	5
8	1	END	1/2 DIA.X 1/8	POLY.	5
9	2	SCREW	*0-80X 1/8	BRASS	5
10	1	WIRE	.001 X 1 3/8	TUNGS.	6
11	1	TROLLEY	.008 X 1 1/8	MUS.W	7
12	4	SCREW	*4-36X 1/2	BRASS	5
13	1	SPRING	.009 X 2	MUS.W.	8
14	1	END	1/2 DIAX 1/8	POLY	5

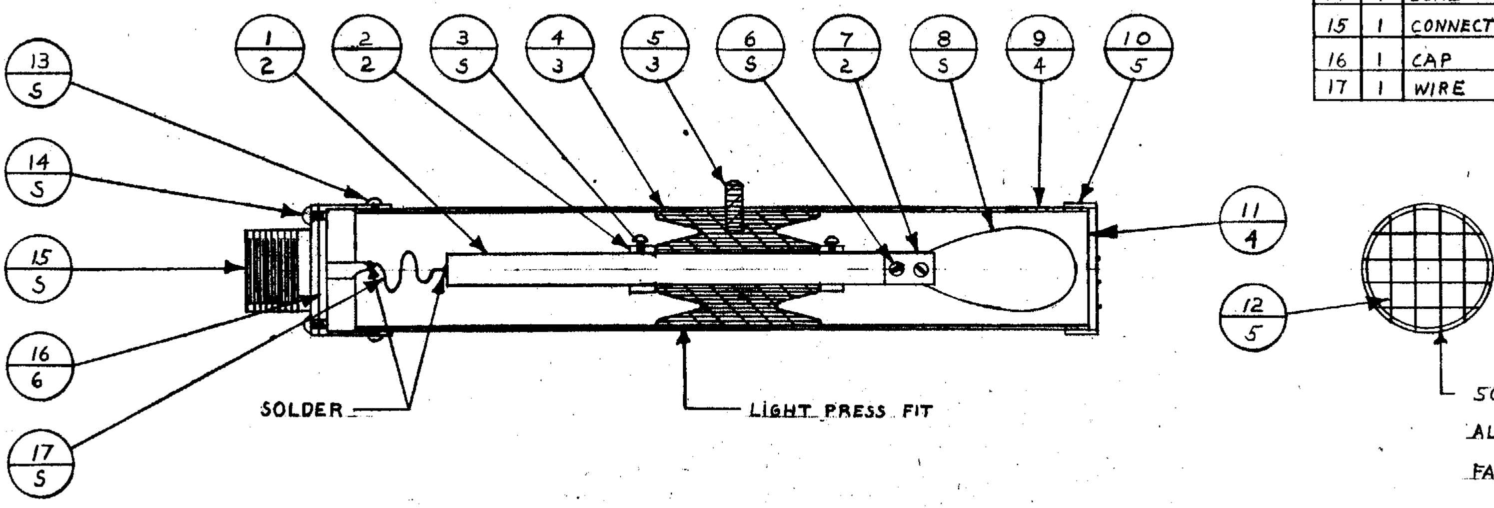


MARK 17 MODEL 19 TYPE A	DRWG. NO. P.C. 10702		
	SHEET NO. 1 OF 8		
	SCALE FULL		
INSTRUMENT SECTION METALLURGICAL LABORATORY UNIVERSITY OF CHICAGO			
DES. BY J.A. SIMPSON JR.		REVISED	DATE
DR. BY G. LOBELL			
DATE 9-18-45			
APP. BY			

51088—144—9-48

DET	QUAN	DESCRIPTION		MAT'L.	SH
1	1	ROD	1/4 DIA X 3 3/4	BRASS	2
2	2	COLLAR	3/8 DIA X 3/16	BRASS	2
3	2	SCREW	# 1-72 X 1/8	BRASS	5
4	1	INSULATOR	7/8 DIA X 1 1/4	POLY	3
5	1	PEG	1/8 DIA. X 3/8	BAKEL	3
6	2	SCREW	# 0-80 X 3/16	BRASS	5
7	1	PLATE	1/4 DIA X 3/8	BRASS	2
8	1	WIRE	002 X 3	TUNG	5
9	1	SHELL	15/16 DIA X 5 5/8	BRASS	4
10	1	RING	1 DIA X 1/4	BRASS	5
11	1	SCREEN	.0002 X 15/16 D.	NYLON	4
12	1	GUARD	3/16 MESH X .015	NICKEL	5
13	2	SCREW	# 1-72 X 1/8	BRASS	5
14	4	SCREW	# 3-56 X 1/8	BRASS	5
15	1	CONNECTOR	83-1RY AMP	POLY	5
16	1	CAP	1 DIA. X 9/16	BRASS	6
17	1	WIRE	.010 X 2	PH. BR.	5





ENLARGED VIEW OF END OF ROD
SHOWING GROOVE SCRATCHED IN
SURFACE TO LOCATE WIRE

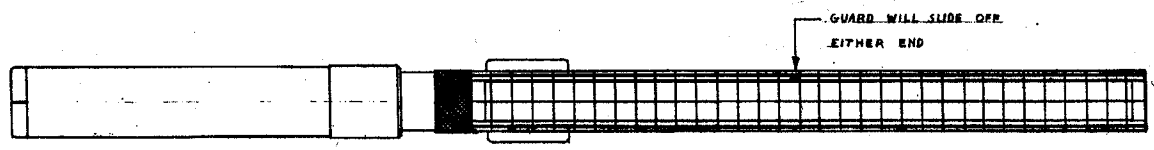
MARK 17 MODEL 20 TYPE A	DRWG. NO. PC 10703
	SHEET NO. 1 OF 6
	SCALE FULL

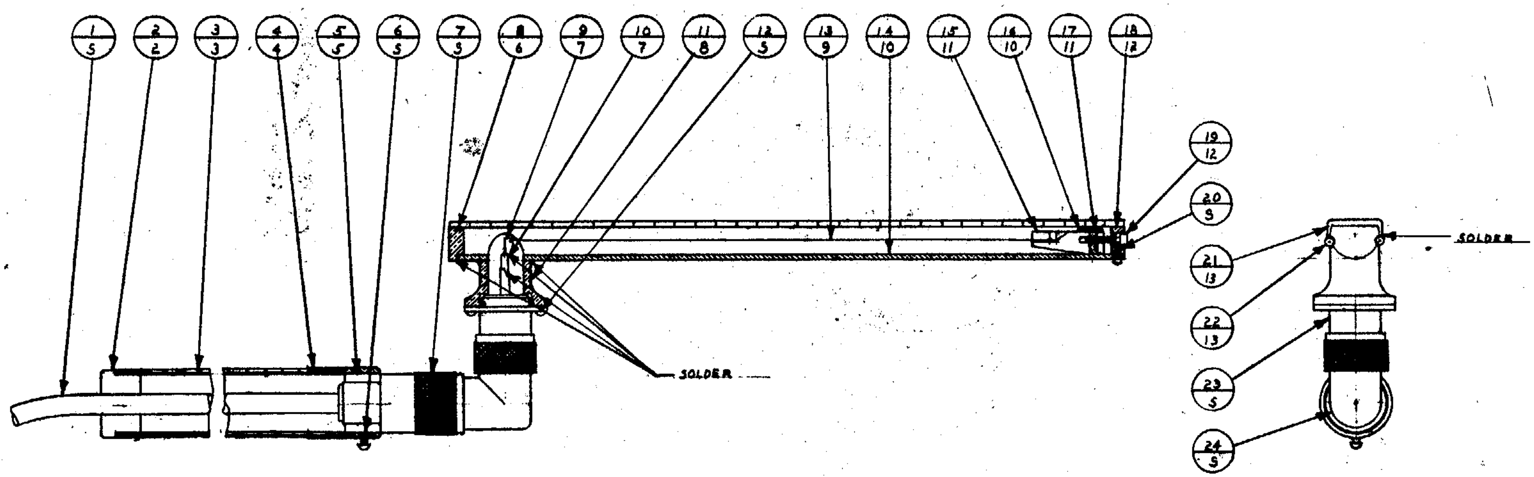
INSTRUMENT SECTION
METALLURGICAL LABORATORY UNIVERSITY OF CHICAGO

DES. BY	J.A. SIMPSON JR.	REVISED	DATE
DR. BY	G. LOBELL		
DATE	9-19-45		
APP. BY			

CP 2851
Fig. 15

DET	QUAN	DESCRIPTION		MAT'L.	SH
1	1	CABLE	RG-54A/U	POLYE	5
2	2	CLAMP	7/8 DIA. X 1/2	BAKEL.	2
3	1	HANDLE	7/8 DIA. X 4 1/8	BAKEL.	3
4	1	RING	15/16 DIA X 7/8	BRASS	4
5	2	SPLIT RING	3/4 DIA. X 7/16	BRASS	5
6	1	SCREW	#4-36 X 1/4	BRASS	5
7	1	CONNECTOR	83-13PD	DIELE	5
8	1	END	5/8 DIA. X 9/16	BRASS	6
9	1	SPRING	.010 X 3/4	MUSWI	7
10	1	PLUG	3/32 DIA X 1/2	BRASS	7
11	1	BASE	3/4 X 1 X 1	BRASS	8
12	4	SCREW	#4-36 X 3/16	BRASS	8
13	1	WIRE	.001 X 6 7/8	TUNGS.	9
14	1	SHELL	5/8 DIA. X 8	BRASS	10
15	1	INSULATOR	1/2 DIA. X 3/8	POLYS	11
16	1	GUIDE	1/32 X 5/16 X 1/2	BRASS	10
17	1	PIN	1/8 DIA. X 1/4	BRASS	11
18	1	END	5/8 DIA. X 3/16	BRASS	12
19	1	TENSION SCREW	5/32 DIA X 1/2	BRASS	12
20	1	SCREW	#0-80 X 1/4	BRASS	5
21	1	GUARD	1/4 MESH X .025	ST. STL	13
22	2	SLIDE	3/32 DIA X 8 1/4	BRASS	13
23	1	CONNECTOR	83-1RY	POLYS	5
24	1	CONNECTOR	83-1AP	POLYS	5





MARK 17 MODEL 16 TYPE A	DWG. NO. PC 10R84 SHEET NO. 1 OF 13 SCALE FULL
INSTRUMENT SECTION METALLURGICAL LABORATORY UNIVERSITY OF CHICAGO	
DES. BY J.A. SIMPSON JR.	REVISED / DATE
DR. BY G. LOBELL	
DATE 9-21-45	
APP. BY	

706 R

14

Argonne National Laboratory

P.O. BOX 5207
CHICAGO 80, ILLINOIS
BUTTERFIELD 1400

Date 11-7-47

To: Clinton Lab.

From: Office Services, Inventory and Audit Unit

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Author: J. A. Simpson

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